

Question No: 1

What are the two focusing methods in CRT? Explain briefly.

Answer:

Page no : 26

1. Electrostatic focusing
2. Magnetic focusing

In electrostatic focusing the electron beam passes through a positively charged metal cylinder that forms an electrostatic lens. Then electrostatic lens focuses the electron beam at the center of the screen.

Similar task can be achieved with a magnetic field setup by a coil mounted around the outside of the CRT envelope. Magnetic lens focusing produces the smallest spot size on the screen and is used in special purpose devices

Question No: 2

What is the relation between triads and shadow mask method?

Answer:

Page no : 29

Shadow mask methods can display a wide range of colors. In this technique each pixel position is made up of three phosphor dots called triads.

Question No: 3

Discuss in brief the pixel drawing methods.

Answer:

Page no : 48

BIOS routines are standard routines built in VGA cards but these routines are very much slow. You will use pixel to draw filled triangle, rectangles and circles and these all will be much slower than direct memory access method. Direct memory access method allows you to write pixel directly by passing the complex BIOS routines. It is easy and faster but its programming is only convenient in mode 13h. Library functions are easier to use and even faster because these are optimized and provided with special drivers by different companies.

Question No: 4

What are the steps involved in performing the boundary fill algorithm, also write the pseudo code for the steps you have mentioned above?

Answer: Page no : 97

The Boundary fill algorithm performs the following steps:

Check the pixel for boundary color

Check the pixel for fill color

Set the pixel in fill color

Run the process for neighbors

The pseudo code for Boundary fill algorithm can be written as:

```
boundaryFill (x, y, fillColor, boundaryColor)
  if ((x < 0) || (x >= width))
    return
  if ((y < 0) || (y >= height))
    return
  current = GetPixel(x, y)
  if ((current != boundaryColor) && (current != fillColor))
    setPixel(fillColor, x, y)
    boundaryFill (x+1, y, fillColor, boundaryColor)
    boundaryFill (x, y+1, fillColor, boundaryColor)
    boundaryFill (x-1, y, fillColor, boundaryColor)
    boundaryFill (x, y-1, fillColor, boundaryColor)
```

Question No: 5

How the locality of a point can be defined with respect to a plane?

Answer: page no 208)(lec no 21)

One of the most important operations planes let you perform is defining the location of a point with respect to a plane. If you drop a point into the equation, it can be classified into three cases: in front of the plane, in back of the plane, or coplanar with the plane. Front is defined as the side of the plane the normal sticks out of.

Question No: 6

Find in which quadrant the point (-2, 3) lies in 2D plane.

Answer:

2nd quadrant

Question No: 7

Consider these 3-D vectors:

$$A = [9,8,7]$$

$$B = [4,7,3]$$

$$C = [2,9,6]$$

Compute :

i) $A \cdot B \times C$

ii) $A \times B \cdot C$

Answer:

$$B \times C = [7 \times 6 - 3 \times 9, 3 \times 2 - 4 \times 6, 4 \times 9 - 7 \times 2]$$

$$= [15, -18, 22]$$

$$A \cdot B \times C = 9 \times 15 + 8 \times (-18) + 7 \times 22 = 135 - 144 + 154 = 145$$

$$A \times B = [8 \times 3 - 7 \times 7, 7 \times 4 - 9 \times 3, 9 \times 7 - 8 \times 4]$$

$$= [-25, 1, 31]$$

$$A \times B \cdot C = -25 \times 2 + 1 \times 9 + 31 \times 6 = -50 + 9 + 186 = 145$$

Question No: 8

What is the main difference between

i) Orthographic projection

ii) Oblique projection

Answer:

Orthographic Projection

If the direction of projection is perpendicular to the projection plane then it is an orthographic projection.

Oblique Projection

If the direction of projection is not perpendicular to the projection plane then it is an oblique projection.

Question No: 9

a) Suppose we want to perform 3D scaling using homogenous coordinates with respect to a point Q (x_1, y_1, z_1) Derive the matrix we should use for this purpose. take ($S_x = 6, S_y = 4, S_z = 7$)

b) Suppose we want to perform 3D Rotation of 180 degrees about Y-Axis using Homogenous coordinates using Reflection, Give the matrix that can do this task.

Answer:

Scaling with respect to a selected fixed position:

Scaling with respect to a selected fixed position (x_1, y_1, z_1) can be represented with the following transformation sequence:

1. Translate the fixed point to the origin.
2. Scale the object relative to the coordinate origin
3. Translate the fixed point back to its original position

$$\begin{bmatrix} 1 & 0 & 0 & x_1 \\ 0 & 1 & 0 & y_1 \\ 0 & 0 & 1 & z_1 \\ 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} S_x & 0 & 0 & 0 \\ 0 & S_y & 0 & 0 \\ 0 & 0 & S_z & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 & 0 & -x_1 \\ 0 & 1 & 0 & -y_1 \\ 0 & 0 & 1 & -z_1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

The reflection transformation operation is equivalent to rotation of 180 degrees so we can use the following transformation matrix using homogenous coordinates to perform the rotation of 180 degrees about y axis

$$\begin{bmatrix} -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Question No: 10

Suppose we want to perform the following operations in 2D using homogenous coordinates

in the order as given below:

- a. Reflection about Y axis
- b. Rotation of + 30 Degrees
- c. Reflection about X axis

Find the resultant composite matrix that can perform this task using the individual 2D transformation matrices using Homogenous coordinates.

You can use the table:

Angle (Degrees)	Sin	Cos
30°	1/2	$\sqrt{3}/2$

Answer:

We can produce Reflection about Y-Axis by matrix

$$\begin{bmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

We can produce Rotation of 30 degrees by matrix

$$\begin{bmatrix} \cos \theta & -\sin \theta & 0 \\ \sin \theta & \cos \theta & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} \cos 30 & -\sin 30 & 0 \\ \sin 30 & \cos 30 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

We can produce Reflection about X-axis by matrix

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \cos 30 & -\sin 30 & 0 \\ \sin 30 & \cos 30 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \sqrt{3}/2 & -1/2 & 0 \\ 1/2 & \sqrt{3}/2 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} -\sqrt{3}/2 & -1/2 & 0 \\ -1/2 & \sqrt{3}/2 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} -\sqrt{3}/2 & -1/2 & 0 \\ 1/2 & -\sqrt{3}/2 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Final Matrix

Question No: 6

Marks: 5

Question No: 11

Why is the Bresenham's line drawing algorithm more efficient than the DDA line drawing algorithm? Give precise one line answer.

Answer: lec no 5 and page no 57

Right Handed Rule:

Answer:

“Right Hand Rule” for rotations: grasp axis with right hand with thumb oriented in positive direction, fingers will then curl in direction of positive rotation for that axis.

Right handed Cartesian coordinate system describes the relationship of the X,Y, and Z in the following manner:

X is positive to the right of the origin, and negative to the left.

- Y is positive above the origin, and negative below it.
- Z is negative beyond the origin, and positive behind it.

Question No:12

What is Viewing Frustum?

Answer: .

Pge 199 and lec no 20

A viewing frustum is 3-D volume in a scene positioned relative to the view port's camera. The shape of the volume affects how models are projected from camera space onto the screen. The most common type of projection, a perspective projection, is responsible for making objects near the camera appear bigger than objects in the distance. For perspective viewing, the viewing frustum can be visualized as a pyramid, with the camera positioned at the tip. This pyramid is intersected by a front and back clipping plane. The volume within the pyramid between the front and back clipping planes is the viewing frustum. Objects are visible only when they are in this volume

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Question No: 13

Give homogeneous translation matrix for 2D transformation.

Answer:

Page 118 and lec 12.

Translation with Homogeneous Coordinates

The translation can now be expressed using homogeneous coordinates as:

$$P' = T(tx, ty) \cdot P$$

Question No: 14

What is meant by Trivial Accept?

Answer:

Trivial Accept - save a line with both endpoints inside all clipping boundaries.

Question No: 15

What is Rendering?

Answer:

Page : 162 lec 16

The process of computing a two dimensional image using a combination of a three-dimensional database, scene characteristics, and viewing transformations. Various algorithms can be employed for rendering, depending on the needs of the application.

Question No:16

Clearly Explain the Following:

- a. **Why in Scan Line Filling Algorithm we don't put the edges having $1/m = 0$ in active edge table.**
- b. **In matrix multiplication the number of columns of first matrix should be equal to number of rows of second matrix.**

- a. **In Scan line filling algorithm we don't put the edges having $1/m$ in active edge table because we treat it as special a case. If this edge is at the minimum y value for all edges, it is drawn. Otherwise, if the edge is at the maximum y value for any edge, we do not draw it.**
- b. **Because we multiply the rows of first matrix by the column of second matrix so if we don't have the number of corresponding elements equal, we would not be able to multiply the matrices.**

Question No: 17

Write the two techniques of triangle rasterization. 2 marks

Answer:

- 1. Smooth Shaded Triangle Rasterization**
- 2. Texture Mapped Triangle Rasterization**

A 2-D polygon can be divided if yes then write the reason?

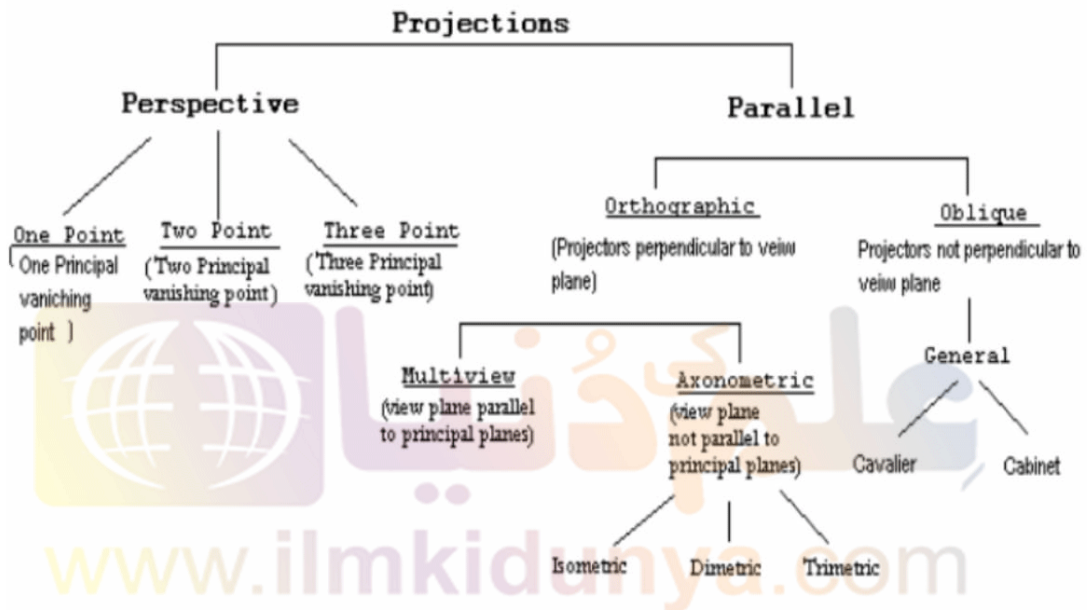
Answer:

A polygon can be translated by applying the $P' = P + T$ to each vertices of the polygon and redrawing the polygon with new coordinates.

Question No: 17

What is the taxonomy of the families of the projection?

Answer:



Question No: 18

Write the formulas of following:

Translation $P' =$

Scaling $P' =$

Rotation $P' =$

Shear $P' =$

Composite Rotation $P' =$

Answer:

Translation: $P' = P + T$

Rotation: $P' = R \cdot P$

Scaling: $P' = S \cdot P$

Composite Rotation:

$$P' = R(\theta_1 + \theta_2) \cdot P$$

Question No:19

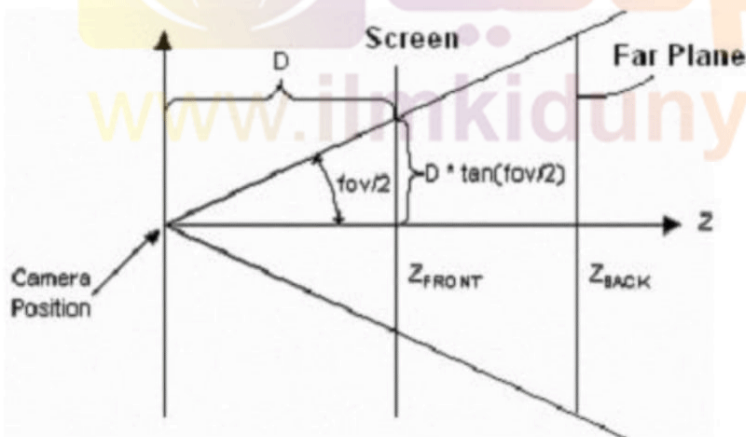
Define rotation in 2d ? (2)

Answer:

A two dimensional rotation is applied to an object by repositioning it along a circular path in the xy plane

Q2. Describe the diagram that is On the 2nd diagram... (5)

Answer: Chapter: 20 page # 200



The viewing frustum is defined by fov (field of view) and by the distances of the front and back clipping planes, specified in z-coordinates. In this illustration, the variable D is the distance from the camera to the origin of the space that was defined in the last part of the geometry pipeline—the viewing transformation. This is the space around which you arrange the limits of your viewing frustum. For information about how this D variable is used to build the projection matrix.

Question No: 20

Formula to find length of the vector.

Answer:

$$|V| = \sqrt{x^2 + y^2 + z^2}$$

Question No: 21

Which algorithm finds the closest integer coordinates to the actual line. Summarize this algorithm and suggest some improvements.

Answer: page no 55 and lec no 5.

Bresenham's algorithm finds the closest integer coordinates to the actual line, using only integer math. Assuming that the slope is positive and less than 1, moving 1 step in the x direction, y either stays the same, or increases by 1. A decision function is required to resolve this choice.

Question No: 22

Scaling with respect to a selected fixed position

Answer: page 185(lec18)

Translate the fixed point to the origin.

Scale the object relative to the coordinate origin

Translate the fixed point back to its original position

Question No: 23

- a. Concave and convex polygons.
- b. Complex and concave polygons. c.
- Filled and Unfilled Polygons.

Answer: (Lec 18) (Page no 78, 79)

Difference between concave and convex polygons

If a straight line connecting any two points that are inside the polygon intersects any edges of the polygon, then this polygon is called Concave polygons, otherwise it will be convex one.

Difference between Complex and Convex polygons

In complex polygons the vertices intersect some edge of the polygon whereas in convex polygons they cannot.

Difference between Filled and Unfilled Polygon

In an unfilled polygon, only the points on the perimeter of the polygon are drawn. Whereas, in filled polygons all the interior points of the polygon must be filled. This means that all of the pixels within the boundaries of the polygon must be set to the specified color or pattern.

Question: 24

- a. How we can find that whether a point lies inside a polygon or not?
- b. Describe one case in which Boundary fill algorithm may fail.

Answer:

a)

To test it, draw a line segment from any point that lies outside the polygon to a point P that we wish to determine whether it is inside or outside of the polygon. Count the number of edges that the line crosses. If the number of polygon edges crossed is odd, then P lies within the polygon. Similarly, if the number of edges is even, then P lies outside of the polygon.

b)

The boundary fill algorithm may fail in the case of Complex Polygons.

Question: 25

1. Suppose a man is standing at the point $P = (-3, 2, 3)$ and it is looking along the vector

$$V = [4, 9, 11]$$

Determine whether the man would be able to see a point $P' (1, 0, 1)$ or not.

2. Find the distance between the points $(-2, 3)$ and $(-6, 6)$

Answer:

First we will find Test vector T as follows:

$$T = [(-3-1), (2-0), (3-1)]$$

So,

$$T = [-4, 2, 2]$$

Now Finding

$$T.V = -16 + 18 + 22$$

$$= +24$$

As $T.V > 0$

Question : 26

Give the resultant point when we apply 2D scaling using homogenous coordinates on the point $P(9,3)$, about the point $P(7,7)$ Take $S_x = 2, S_y = 3$.

Answer:

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AS the matrix for scaling with respect to point P(x,y) is

$$\begin{bmatrix} Sx & 0 & (1-Sx)x \\ 0 & Sy & (1-Sy)y \\ 0 & 0 & 1 \end{bmatrix}$$

So the result would be

$$\begin{bmatrix} 2 & 0 & (-1)7 \\ 0 & 3 & (-2)7 \\ 0 & 0 & 1 \end{bmatrix}$$

When we apply it on point P(9,3), we get the result as follows

$$\begin{aligned} &= \begin{bmatrix} 2 & 0 & (-1)7 \\ 0 & 3 & (-2)7 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 9 \\ 3 \\ 1 \end{bmatrix} \\ &= \begin{bmatrix} 18+0+(-7) \\ 0+9+(-14) \\ 0+0+1 \end{bmatrix} \\ &= \begin{bmatrix} 11 \\ -5 \\ 1 \end{bmatrix} \end{aligned}$$

So our resultant point would be P'(11,-5)

Question : 27

How can we tackle edges meeting at a vertex and for both edges the vertex is the minimum point in scan line filling algorithm.

Answer:

We tackle the edges meeting at a vertex in scan line by incrementing the parity in scan line algorithm twice and filling the point at the vertex.

Question : 28

In which of planes given below the Point P(2,0,3) lies

i) xy plane

ii) yz plane

iii) zx plane

Answer:

ZX plane.

Question : 29

Why the Cohen-Sutherland Line-Clipping Algorithm involves much more calculations than the other line clipping algorithms.

Answer:

We need much more calculations in Cohen Sutherland line clipping Algorithm because we have to perform trivial accept / Reject test for every point on the line this consumes a lot of computational power and time.

Question : 30

What could be the ways to implement area filling on raster systems? Summarize scan line polygon filling algorithm in your own words.

Answer:

One way is to draw straight lines between the edges of polygon called scan-line polygon filling. Second way is to start from an interior point and paint outward from this point till we reach the boundary called boundary-fill.